Industrial Hazard Safety and Risk Reduction

Introduction

Disaster risk is increasing globally due to the growing exposure of human activities, combined with increasing vulnerabilities and the effects of climate change and global warming. This escalation is primarily attributed to a combination of unplanned urban development, vulnerable livelihoods, and ecosystem degradation. It is now widely recognized that a substantial number of disasters are preventable outcomes of inadequately managed risks. These efforts are aimed to conserve development gains and minimizing losses to lives, livelihoods, and property. Integrating DRR into investment decisions is one of the most cost-effective way to reduce these risks. Therefore, investing in DRR becomes a prerequisite for sustainable development, especially in the face of a changing climate.

Increased industrial activities and the risks associated with hazardous materials enhanced vulnerability lead to industrial and chemical accidents. Accidents in Micro, Small and Medium Enterprises (MSMEs)may originate in the manufacturing or formulation facility, or during the process operations at any stage of the product cycle, material handling, transportation and storage. Vulnerability is sometimes compounded due to the location of Major Accident Hazard (MAH) industries/units closer to densely populated areas. Chemical and industrial accidents generally occur due to technical failures that can be anticipated. The risk associated with them can thus be predicted and reduced effectively by identification of risk areas, risk assessment and designing pre-operative measures.

Background

India is exposed to multiple hazards and has experienced several disasters in the past such as cyclones, Tsunami, floods, landslides and earthquakes. Due to global warming and climate change, it is observed that over the years the frequency of extreme events such as forest fire, lightening, urban flooding, torrential rain, heatwaves and cloud bursts have increased tremendously. The frequency of human-induced disasters such as urban fires and industrial accidents have also increased. These catastrophic events have created a significant impact on small and medium sized industries (MSME) during recent years. Manufacturing sector has emerged as one of the high growth sectors in India. India continues to emerge as one of the world's fastest-growing infrastructure and construction markets, driven by rapid urbanization, industrial growth, and large-scale public investments.

The Government of India has launched major initiatives such as the ₹100 lakh crore National Infrastructure Pipeline (NIP) and the PM Gati Shakti National Master Plan to strengthen connectivity, economic growth, and resilient infrastructure development across the country. (IBEF, 2021). Since, the industrial sector is expected to grow in the future, industrial safety, infrastructure improvements, and industrial disaster management plans will become increasingly vital.

Given the increasing occurrence of multi-hazard emergencies in the industrial sector, there is an urgent need for development of onsite site off site Disaster Management Plan of industrial units and large-scale capacity-building programme for induatrial workers. It would support in creating a conducive built environment and preventing the re-building of disasters in industrial units. The collaboration of various sectors is crucial for achieving this goal.

Context

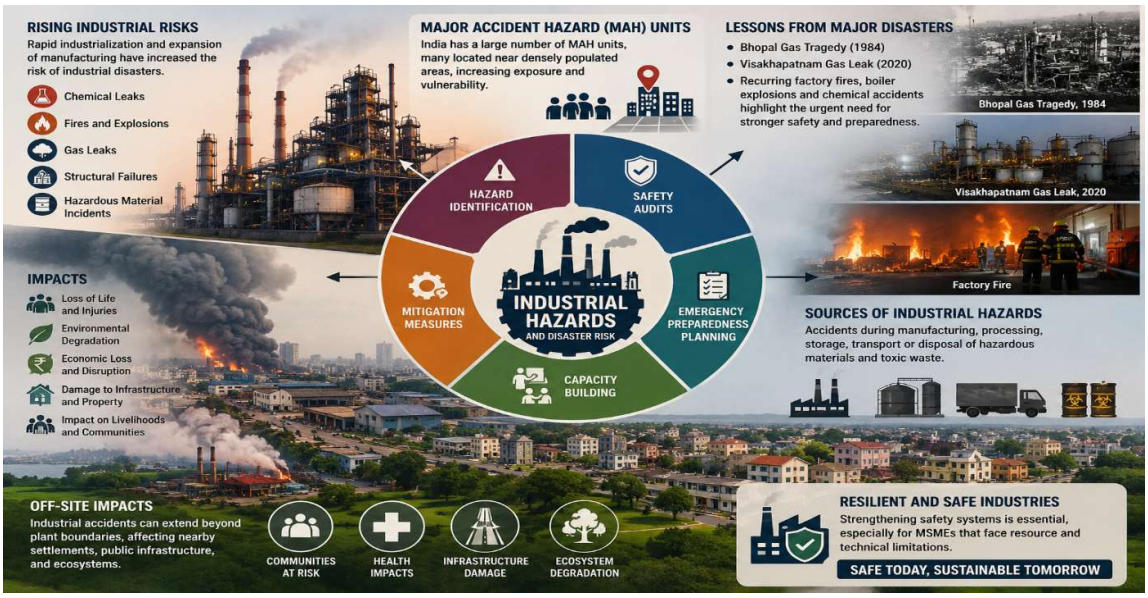
Rapid industrialization and expansion of manufacturing activities in India have significantly increased the risk of industrial disasters, including chemical leaks, fires, explosions, gas leaks, structural failures, and hazardous material incidents. According to the National Disaster Management Authority, the country has a large number of Major Accident Hazard (MAH) units, many of which are situated near

densely populated urban and peri-urban regions, thereby increasing exposure and vulnerability to industrial accidents.

Major industrial disasters such as the Bhopal Gas Tragedy and the Visakhapatnam Gas Leak, along with recurring factory fires, boiler explosions, and chemical accidents, have highlighted the urgent need for strengthened industrial safety systems and disaster preparedness mechanisms. Government data indicates that industrial fires, electrical hazards, and chemical incidents continue to result in loss of life, environmental degradation, and economic disruption every year.

Industrial hazards may arise from accidents during manufacturing, processing, storage, transportation, or disposal of hazardous materials and toxic waste. Such incidents can have both immediate and long-term consequences on human health, infrastructure, livelihoods, and the environment. Similar to natural disasters, industrial hazards are characterized by their occurrence in time and space, their impact on communities and institutions, and the response measures adopted to reduce associated risks.

The off-site impacts of industrial accidents often extend beyond the industrial premises, affecting nearby settlements, public infrastructure, and ecosystems. These risks underline the critical importance of hazard identification, safety audits, emergency preparedness planning, capacity building, and implementation of effective mitigation measures, particularly for Micro, Small and Medium Enterprises (MSMEs), which frequently face technical, financial, and institutional limitations in adopting comprehensive safety systems.



Initiators of Accidents in MSMEs

A number of factors, including technical failures, unsafe practices, and organizational gaps, can trigger industrial accidents with the potential to escalate into major disasters. Industrial incidents are often the result of a combination of interconnected failures rather than a single cause. The major contributing factors are outlined below:

Regulatory Framework and Codes of Practises

A number of regulations covering safety in transportation, insurance, liability and compensations were enacted in view of industrial hazards and safety .The regulatory framework on Industrial safety are:

Category	Act / Provision	Key Provisions Related to Industrial Disaster Management	Penalties / Liabilities for Non-Compliance
1	**Factories Act, 1948**	Applicable to factories handling hazardous processes. Sections 41B & 41C mandate On-Site Emergency Plans, disaster preparedness	Imprisonment up to 2 years and/or monetary fines.

		measures, safety systems, and worker training.	
2	**Environment (Protection) Act, 1986**	Umbrella legislation governing environmental and industrial safety. Enforces MSIHC Rules, 1989 requiring hazard identification, risk assessment, and on-site/off-site emergency planning.	Imprisonment up to 5 years, fines, and closure of industrial units.
3	**Disaster Management Act, 2005**	Mandates disaster preparedness and integration with District and State Disaster Management Plans. District Disaster Management Authorities (DDMAs) can direct industries to prepare DMPs.	Penalties and prosecution under Sections 51–60 of the Act.
4	**MSIHC Rules, 1989** *(under EPA 1986)*	Mandatory for industries handling hazardous chemicals. Requires written On-Site Emergency Plans, coordination for Off-Site Plans, and periodic mock drills.	Regulatory action, penalties, suspension, or closure for non-compliance.
5	**Public Liability Insurance Act, 1991**	Mandates insurance coverage for hazardous industries to provide immediate relief to accident victims.	Heavy penalties and restrictions on industrial operations without compliance.
6	**Explosives Act, 1884**	Regulates manufacture, possession, use, sale, transport, and storage of explosives to ensure public safety and accident prevention.	Cancellation of licenses, fines, imprisonment, and legal prosecution for unsafe handling/storage.
7	**Petroleum Act, 1934**	Governs import, transport, storage, production, refining, and handling of petroleum products to minimize fire and explosion risks.	Penalties include fines, imprisonment, suspension of licenses, and closure of unsafe facilities.

Industrial Disaster Preparedness, Safety Compliance and Emergency Management in MSMEs

To strengthen industrial safety and reduce the risk of technological and chemical disasters, industries—particularly Micro, Small and Medium Enterprises (MSMEs)—must establish comprehensive disaster preparedness and emergency management systems in compliance with national safety regulations and disaster management guidelines. Industrial units handling hazardous materials are required to maintain a documented **On-Site Disaster Management Plan** covering hazard identification, emergency response mechanisms, evacuation procedures, resource mobilization, and coordination protocols with district authorities.

A systematic **Risk Assessment** process, including Hazard Identification should be conducted to identify potential fire, explosion, toxic release, structural, electrical, and process-related hazards. Industries must establish emergency response systems for incidents such as fires, chemical leaks, explosions, and toxic releases, supported by alarm systems, firefighting arrangements, spill containment mechanisms, emergency shutdown procedures, and medical response facilities.

Coordination with District Administration, Fire Services, Police, Health Departments, and District Disaster Management Authorities (DDMAs) is essential for integrating industrial emergency response with district-level Off-Site Emergency Plans. Industries must also conduct periodic mock drills and simulation exercises to evaluate preparedness, test emergency response capabilities, and improve coordination among internal response teams and external agencies. Regular training and capacity-building programmes should be organized for workers, supervisors, rescue teams, and Quick Response Teams (QRTs), including the use of personal protective equipment (PPE), evacuation protocols, and first-aid measures.

Self Glow Evacuation plans indicating safe routes, assembly points, emergency exits, and refuge areas should be prominently displayed throughout industrial premises to facilitate safe movement during emergencies. Safety audit reports, statutory inspections, and periodic testing of emergency systems must be conducted regularly to identify gaps and ensure

compliance with safety regulations. Although safety audits are mandated periodically under statutory provisions, many industries fail to conduct them effectively, thereby increasing vulnerability to industrial accidents.

Industries should also develop detailed **commissioning and decommissioning plans** for hazardous installations, as accidents frequently occur during startup, shutdown, maintenance, or dismantling operations. Such plans should be submitted to relevant regulatory authorities and integrated into the overall disaster management framework.

Testing of **On-Site Emergency Plans** at least once every six months and full-scale mock drills for **Off-Site Emergency Plans** at district level are essential statutory requirements. However, many industrial units conduct only partial or limited exercises. Comprehensive drills involving the entire installation, district authorities, emergency responders, and nearby communities are necessary to evaluate real-time preparedness and response effectiveness.

Preparation of Standard Operating Procedures (SOPs) for rescue teams and emergency responders is critical, particularly for hazardous chemical environments. SOPs should include protocols for wearing full protective gear, hazardous area entry, cordoning of affected sites, decontamination procedures, and casualty evacuation. Establishment of decontamination facilities within both On-Site and Off-Site emergency systems is especially important for Major Accident Hazard (MAH) units handling toxic substances.

Development of a comprehensive **Resource and Risk Inventory** is another important component of industrial disaster management. Industries should maintain updated resource directories containing details of emergency equipment, firefighting systems, ambulances, hospitals, response personnel, mutual aid partners, contact numbers, and logistics support systems. Simultaneously, a detailed inventory of hazardous chemicals and toxic substances along with their health and environmental impacts should be prepared for effective emergency medical management and environmental response planning.

For MSMEs and industrial clusters, disaster management resources and emergency response capacities should be developed in proportion to the assessed risks. Additional safety measures should include:

- Training and availability of paramedics and emergency medical teams.
- Well-planned evacuation routes with minimum congestion.
- Efficient, leak-proof storage and handling systems.
- Community awareness and preparedness programmes.
- Medical preparedness for industrial toxic release incidents.
- Identification and training of community leaders and volunteers.
- Strengthening mutual aid arrangements and inter-district resource mobilization systems.

A comprehensive approach integrating risk assessment, preparedness planning, emergency response, safety audits, training, mock drills, and institutional coordination is essential for building resilient industrial systems and minimizing the human, environmental, and economic impacts of industrial disasters.

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